**Objectives**

* Use the concept of buoyancy to explain how magmas rise

**Causal Principles**

1. Gravitational energy, thermal energy, and/or chemical **energy** drive all movement and change of matter on Earth.

2. A system is in **equilibrium** when energy in the system is balanced.

1. **Temperature** is a measure of the movement of molecules. Higher temperature means molecules are moving faster.
2. When molecules move faster, the **density** of most substances decreases. Water is an anomaly because liquid water is more dense than ice.
3. **Buoyancy** causes materials to rise or fall due to the relative density of materials.

**PART 1: Background Notes**

**Class Notes**

|  |  |
| --- | --- |
| Table A. Causal Principles and Hot Air Balloon | |
| **Hot Air Balloon** | **Principle** |
| Gas flame | Chemical Energy, Temperature |
| Differences in air inside and outside the balloon | Temperature, density |
| Balloon rising | Density, buoyancy |
| Balloon floating | Equilibrium, |
| Outside air heating up during the day | Chemical Energy, Thermal Energy, Temperature |

|  |  |
| --- | --- |
| Table B. Causal Principles and Magma | |
| **Magma** | **Principle** |
| Water added to hot rocks deep underground | Density |
| Differences in the cold lithosphere and the hot magma | Density, Temperature |
| Magma rising | Buoyancy, Density |
| Magma solidifies and stops rising | Temperature, Density reach equilibrium, |
| Oceanic lithosphere versus continental lithosphere | Density |

**Part 2. Group Work**

In Table C, align the principles that correspond between the hot air balloon and the magma. Then explain how the hot air balloon and magma are different in Table D.

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| --- | --- | --- |
| Table C. Comparing Hot Air Balloon and Magma | | |
| **Hot Air Balloon** | **Magma** | **Principle** |
| Gas flame | Heat from Earth’s core | Energy, |
| Differences in air inside and outside the balloon | Temperature and density differences in magma | Temperature, Density |
| Balloon rising | Magma Rising | Buoyancy, Density |
| Balloon floating | Magma at surface | Equilibrium |
| Outside air heating up during the day | No connection |  |

|  |  |  |
| --- | --- | --- |
| Table D. Differences Between Hot Air Balloon and Magma | | |
| **Hot Air Balloon** | **Difference** | **Magma** |
| Temperature | Factors impacting density of balloon/magma | Chemical composition |
| Density of surrounding air | Factors impacting buoyancy | Chemical composition |

**Part 3: Homework**

When magmas rise close to the surface, gas bubbles in the magma leak out fractures. An analogy to this would be if a hot air balloon had a hole.

* 1. How do the gas bubbles affect the density of the magma?

Gas bubbles make magma lighter

* 1. If the gas leaves the magma, how would it impact the buoyancy of the magma?

As gas leaves, magma becomes denser and would stop rising

* 1. Would the magma continue to rise or stop rising and cool in place?

The magma would cool in place because it would have reached equilibrium

During subduction, water found in minerals of the oceanic lithosphere is released into the mantle. This process causes magma to form.

1. How does the water affect the melting point of the surrounding rock?

It cools the rocks down because the water gets turned in to a gas.

1. Once the rock is magma, why does it rise?

Magma is less dense due to its temperature

1. The lithosphere is solid rock. How does the magma change the surrounding rock so that it can rise through solid rock?

It partially melts it and cracks the surrounding rocks.